Document details

Back to results | 1 of 1

International Food Research Journal
Volume 24, 2017, Pages 514-521

Optimization of essential oil and fucoxanthin extraction from Sargassum binderi by supercritical carbon Dioxide (SC-CO_2) extraction with ethanol as co-solvent Using Response Surface Methodology (RSM) (Article)

Jaswir, I.[abc], Noviendri, D.[a], Taher, M.[d], Mohamed, F.[d], Salleh, H.M.[a], Octavianti, F.[e], Lestari, W.[f], Hendri, R.[g], Abdullah, A.[h], Miyashita, K.[i], Hasna, A.[a]

[a]Bioprocess and Molecular Engineering Research Unit (BPMERU), Department of Biotechnology Engineering, Faculty of Engineering, International Islamic University Malaysia (IIUM), Gombak, Kuala Lumpur, Malaysia
[b]International Institute for Halal Research and Training (INHART), International Islamic, University Malaysia (IIUM), Gombak, Kuala Lumpur, Malaysia
[c]Marine Natural Products Research Centre, Surya University, Tangerang, Indonesia

View additional affiliations

Abstract

View references (46)

Supercritical carbon dioxide (SC-CO_2) extraction of fucoxanthin is more advantageous over conventional solvent extraction as it is less toxic, less hazardous to the environment and preserves the bioactivity of fucoxanthin. A face-centered central composite design (FCCCD) based on response surface methodology (RSM) was employed for SC-CO2 extraction of oils and fucoxanthin from the brown seaweed Sargassum binderi, with ethanol as a co-solvent. Three independent parameters namely, extraction temperature (A: 40, 50, 60°C), pressure (B: 2900, 3625, 4350 psig and particle size (C: 90, 500 and 1000 µm) were investigated to optimize extraction oil yields (EOY) and fucoxanthin yields (FY). A regression model was developed, tested for quality of fit (R^2) and expressed in the form of 3D response surface curve and 2D contour. The optimum extraction conditions were obtained at extraction temperature (A) 50°C, pressure (B) 3625 psig and particle size (C) 500 µm. Under these conditions, optimal EOY and FY were 10.04 mg/g and 3188.99 µg/g, respectively. The difference between the lowest and the highest response in EOY and FY were 5.44 - 10.04 mg/g and 2109.10 - 3188.90 µg/g, respectively. The lowest yields were identified at 60°C, 2900 psig and 1000 µm. The regression models generated showing interactions between the variables and EOY and FY response were significant as tested by ANOVA ($p < 0.0005$ and $p < 0.0007$, respectively) with high R^2 values (0.9848 and 0.9829, respectively). Interactions between the parameters had a strong synergistic effect on EOY and FY values, as indicated by the 3D response surface curve and 2D contour. The experimental results matched the predicted results closely. This indicated the suitability of the models developed and the success of FCCCD under RSM in optimizing the S. binderi extraction conditions.

Reaxys Database Information

View Compounds

Author keywords

Fucoxanthin | Methodology | Response surface | Sargassum binderi | Supercritical carbon dioxide

ISSN: 19854668
Source Type: Journal
Original language: English
Document Type: Article
Publisher: Universiti Putra Malaysia

References (46)

View in search results format

Metrics

0 Citations in Scopus

0 Field-Weighted Citation Impact

PlumX Metrics

Usage, Captures, Mentions, Social Media and Citations beyond Scopus.

Cited by 0 documents

Inform me when this document is cited in Scopus:

Set citation alert

Set citation feed

Related documents

Solvent Extraction of Fucoxanthin from Phaeodactylum tricornutum
Kim, J.-C.
(2014) Separation Science and Technology (Philadelphia)

Analysis of fucoxanthin content and purification of all-trans-fucoxanthin from turbinaria turbinata and sargassum plagyophyllum by SiO2open column chromatography and reversed phase-HPLC
Jaswir, I. , Noviendri, D. , Salleh, H.M.
(2013) Journal of Liquid Chromatography and Related Technologies

Supercritical carbon dioxide extraction of fucoxanthin from undaria pinnatifida
Quitain, A.T. , Kai, T. , Sasaki, M.
(2013) Journal of Agricultural and Food Chemistry

View all related documents based on references

1 Abbas, K.A., Mohamed, A., Abdulamir, A.S., Abas, H.A.
A review on supercritical fluid extraction as new analytical method

(2008) *American Journal of Biochemistry and Biotechnology*, 4 (4), pp. 345-353. Cited 43 times.
http://www.scipub.org/fulltext/ajbb/ajbb44345-353.pdf
doi: 10.3844/ajbbsp.2008.345.353

View at Publisher

2 Baek, J.-K., Kim, S., Lee, G.-S., Shim, J.-J.
Density Correlation of Solubility of C. I. Disperse Orange 30 Dye in Supercritical Carbon Dioxide

(2004) *Korean Journal of Chemical Engineering*, 21 (1), pp. 230-235. Cited 17 times.

View at Publisher

3 Bari, Md.N., Alam, Md.Z., Muyibi, S.A., Jamal, P., Abdullah-Al-Mamun
Improvement of production of citric acid from oil palm empty fruit bunches: Optimization of media by statistical experimental designs

(2009) *Bioresource Technology*, 100 (12), pp. 3113-3120. Cited 49 times.
doi: 10.1016/j.biortech.2009.01.005

View at Publisher

4 Chen, D., Han, Y., Gu, Z.
Application of statistical methodology to the optimization of fermentative medium for carotenoids production by Rhodobacter sphaeroides

(2006) *Process Biochemistry*, 41 (8), pp. 1773-1778. Cited 47 times.
doi: 10.1016/j.procbio.2006.03.023

View at Publisher

5 Dembitsky, V.M., Maoka, T.
Allenic and cumulenic lipids

(2007) *Progress in Lipid Research*, 46 (6), pp. 328-375. Cited 74 times.
doi: 10.1016/j.plipres.2007.07.001

View at Publisher

6 Döker, O., Salgin, U., Yildiz, N., Aydoğmuş, M., Çalimli, A.
Extraction of sesame seed oil using supercritical CO2 and mathematical modeling

(2010) *Journal of Food Engineering*, 97 (3), pp. 360-366. Cited 44 times.
doi: 10.1016/j.jfoodeng.2009.10.030

View at Publisher

7 Foster, N.R., Singh, H., Yun, S.L.J., Tomasko, D.L., Macnaughton, S.J.
Polar and Nonpolar Cosolvent Effects on the Solubility of Cholesterol in Supercritical Fluids

(1993) *Industrial and Engineering Chemistry Research*, 32 (11), pp. 2849-2853. Cited 62 times.
doi: 10.1021/ie00023a056

View at Publisher

8 Gu, Z., Deming, C., Yongbin, H., Zhigang, C., Feirong, G.
Optimization of carotenoids extraction from Rhodobacter sphaeroides

(2008) *LWT - Food Science and Technology*, 41 (6), pp. 1082-1088. Cited 45 times.
doi: 10.1016/j.lwt.2007.07.005

View at Publisher

9 Heo, S.-J., Jeon, Y.-J.

Protective effect of fucoxanthin isolated from Sargassum siliquastrum on UV-B induced cell damage

(2009) *Journal of Photochemistry and Photobiology B: Biology*, 95 (2), pp. 101-107. Cited 100 times.
doi: 10.1016/j.jphotobiol.2008.11.011

View at Publisher

10 Hossain, M.B., Barry-Ryan, C., Martin-Diana, A.B., Brunton, N.P.

Optimisation of accelerated solvent extraction of antioxidant compounds from rosemary (Rosmarinus officinalis L.), marjoram (Origanum majorana L.) and oregano (Origanum vulgare L.) using response surface methodology

(2011) *Food Chemistry*, 126 (1), pp. 339-346. Cited 81 times.
doi: 10.1016/j.foodchem.2010.10.076

View at Publisher

11 Ismail, A.F., Abdalmonemdoolaanea, Awang, M., Mohamed, F.

High initial burst release of gentamicin formulated as PLGA microspheres implant for treating orthopaedic infection

(2012) *International Journal of Pharmacy and Pharmaceutical Sciences*, 4 (SUPPL. 4), pp. 685-691. Cited 14 times.
http://www.ijppsjournal.com/Vol4Suppl4/4819.pdf

12 Jaswir, I., Noviendri, D., Salleh, H.M., Miyashita, K.
Techniques of Extraction and Purification of Fucoxanthin from Brown Seaweeds
(2011) *Experimental methods in Modern Biotechnology Engineering*
Noorbatcha, I.A., Karim, M.I.A. and Salleh, H.M. (Eds.), 1st ed. Kuala Lumpur: IIUM Press

13 Jaswir, I., Noviendri, D., Salleh, H.M., Taher, M., Miyashita, K., Ramli, N.

Analysis of fucoxanthin content and purification of all-trans-fucoxanthin from turbinaria turbinata and sargassum plagyophyllum by SiO_2 open column chromatography and reversed phase-HPLC

(2013) *Journal of Liquid Chromatography and Related Technologies*, 36 (10), pp. 1340-1354. Cited 12 times.
doi: 10.1080/10826076.2012.691435

View at Publisher

14 Kim, S.M., Jung, Y.-J., Kwon, O.-N., Cha, K.H., Um, B.-H., Chung, D., Pan, C.-H.

A potential commercial source of fucoxanthin extracted from the microalga Phaeodactylum tricornutum

(2012) *Applied Biochemistry and Biotechnology*, 166 (7), pp. 1843-1855. Cited 87 times.
doi: 10.1007/s12010-012-9602-2

View at Publisher

15 Kim, S.M., Shang, Y.F., Um, B.-H.

A preparative method for isolation of fucoxanthin from Eisenia bicyclis by centrifugal partition chromatography

(2011) *Phytochemical Analysis*, 22 (4), pp. 322-329. Cited 31 times.
doi: 10.1002/pca.1283

View at Publisher

16 Lang, Q., Wai, C.M.
Supercritical fluid extraction in herbal and natural product studies - A practical review

(2001) *Talanta*, 53 (4), pp. 771-782. Cited 368 times.
doi: 10.1016/S0039-9140(00)00557-9

View at Publisher

17 Li, P., Xu, L., Mou, Y., Shan, T., Mao, Z., Lu, S., Peng, Y., (...), Zhou, L.
Medium optimization for exopolysaccharide production in liquid culture of endophytic fungus Berkleasmium sp. Dzf12

(2012) *International Journal of Molecular Sciences*, 13 (9), pp. 11411-11426. Cited 7 times.
http://www.mdpi.com/1422-0067/13/9/11411/pdf
doi: 10.3390/ijms130911411

View at Publisher

18 Machmudah, S., Kawahito, Y., Sasaki, M., Goto, M.
Effect of Supercritical Carbon Dioxide Condition on Extraction of Carotenoids and Seed Oil from Rosehip Fruits
(2007) *Proceeding of the International Symposium on EcoTopia Science*, pp. 569-573.
Nagoya: EcoTopia Science Institute

19 Maeda, H., Hosokawa, M., Sashima, T., Takahashi, N., Kawada, T., Miyashita, K.
Fucoxanthin and its metabolite, fucoxanthinol, suppress adipocyte differentiation in 3T3-L1 cells

(2006) *International Journal of Molecular Medicine*, 18 (1), pp. 147-152. Cited 121 times.
http://www.spandidos-publications.com/serveFile/ijmm_18_1_147_PDF.pdf?type=article&article_id=ijmm_18_1_147&item=PDF

View at Publisher

20 Maeda, H., Tsukui, T., Sashima, T., Hosokawa, M., Miyashita, K.
Seaweed carotenoid, fucoxanthin, as a multi-functional nutrient

(2008) *Asia Pacific Journal of Clinical Nutrition*, 17 (SUPPL. 1), pp. 196-199. Cited 78 times.
http://apjcn.nhri.org.tw/server/APJCN/Volume17/vol17suppl.1/196-199S11-4.pdf

21 Matsuno, T.
Aquatic animal carotenoids

(2001) *Fisheries Science*, 67 (5), pp. 771-783. Cited 156 times.
doi: 10.1046/j.1444-2906.2001.00323.x

View at Publisher

22 Miyashita, K.
(2008) *Encyclopedia of Cancer. Fucoxanthin*, p. 2.
New York: Springer-Verlag Berlin Heidelberg

23 Mori, K., Ooi, T., Hiraoka, M., Oka, N., Hamada, H., Tamura, M., Kusumi, T.
Fucoxanthin and its metabolites in edible brown algae cultivated in deep seawater
(2004) *Marine Drugs*, 2 (2), pp. 63-72. Cited 69 times.

24 Muntari, B., Amid, A., Mel, M., Jami, M.S., Salleh, H.M.

Recombinant bromelain production in Escherichia coli: Process optimization in shake flask culture by response surface methodology

(2012) *AMB Express*, 2 (1), pp. 1-9. Cited 18 times.
doi: 10.1186/2191-0855-2-12

View at Publisher

25 Muralidhar, R.V., Chirumamila, R.R., Marchant, R., Nigam, P.

A response surface approach for the comparison of lipase production by Candida cylindracea using two different carbon sources

(2001) *Biochemical Engineering Journal*, 9 (1), pp. 17-23. Cited 333 times.
doi: 10.1016/S1369-703X(01)00117-6

View at Publisher

26 Muthukumaran, P., Gupta, R.B., Sung, H.-D., Shim, J.-J., Bae, H.-K.

Dye solubility in supercritical carbon dioxide. Effect of hydrogen bonding with cosolvents

(1999) *Korean Journal of Chemical Engineering*, 16 (1), pp. 111-117. Cited 36 times.
http://www.springerlink.com/content/120599/
doi: 10.1007/BF02699013

View at Publisher

27 Nakazawa, Y., Sashima, T., Hosokawa, M., Miyashita, K.

Comparative evaluation of growth inhibitory effect of stereoisomers of fucoxanthin in human cancer cell lines

(2009) *Journal of Functional Foods*, 1 (1), pp. 88-97. Cited 42 times.
doi: 10.1016/j.jff.2008.09.015

View at Publisher

28 Naranjo-Modad, S., López-Munguía, A., Vilarem, G., Gaset, A., Bárzana, E.

Solubility of purified lutein diesters obtained from Tagetes erecta in supercritical CO_2 and the effect of solvent modifiers

(2000) *Journal of Agricultural and Food Chemistry*, 48 (11), pp. 5640-5642. Cited 30 times.
doi: 10.1021/jf000121i

View at Publisher

29 Nobre, B., Marcelo, F., Passos, R., Beirão, L., Palavra, A., Gouveia, L., Mendes, R.

Supercritical carbon dioxide extraction of astaxanthin and other carotenoids from the microalga Haematococcus pluvialis

(2006) *European Food Research and Technology*, 223 (6), pp. 787-790. Cited 70 times.
doi: 10.1007/s00217-006-0270-8

View at Publisher

30 Nik Norulaini, N.A., Anuar, O., Abbas, F.M.A., Fatehah, M.O., Mohd Omar, A.K., Sahena, F., Zaidul, I.S.M.

Optimization of supercritical CO_2 extraction of Anastatica hierochuntica

(2009) *Food and Bioproducts Processing*, 87 (2), pp. 152-158. Cited 16 times.
doi: 10.1016/j.fbp.2008.09.001

View at Publisher

31 Noviendri, D., Jaswir, I., Salleh, H., Taher, M., Miyashita, K.
(2011) *Techniques of Extraction and Purification of Carotenoid (Fucoxanthin) from Brown Seaweed. Workshop on Seaweed Processing for Pharmaceutical Applications*, p. 26.
Organized by Bioprocess and Molecular Engineering Research Unit (BPMERU), Department of Biotechnology Engineering, Faculty of Engineering, International Islamic University Malaysia (IIUM), Kuala Lumpur, Malaysia. 16th May 2011, Kuala Lumpur: IIUM

32 Noviendri, D., Jaswir, I., Salleh, H.M., Taher, M., Miyashita, K., Ramli, N.
Fucoxanthin extraction and fatty acid analysis of Sargassum binderi and S. duplicatum

(2011) *Journal of Medicinal Plants Research*, 5 (11), pp. 2405-2412. Cited 19 times.
http://www.academicjournals.org/JMPR/PDF/pdf2011/4June/Noviendri%20et%20al.pdf

33 Roh, H.-S., Park, J.-Y., Park, S.-Y., Chun, B.-S.
Isolation of off-flavors and odors from tuna fish oil using supercritical carbon dioxide

(2006) *Biotechnology and Bioprocess Engineering*, 11 (6), pp. 496-502. Cited 22 times.
doi: 10.1007/BF02932073

View at Publisher

34 Roh, M.-K., Uddin, Md.S., Chun, B.-S.
Extraction of fucoxanthin and polyphenol from Undaria pinnatifida using supercritical carbon dioxide with co-solvent

(2008) *Biotechnology and Bioprocess Engineering*, 13 (6), pp. 724-729. Cited 49 times.
doi: 10.1007/s12257-008-0104-6

View at Publisher

35 Romo-Hualde, A., Yetano-Cunchillos, A.I., González-Ferrero, C., Sáiz-Abajo, M.J., González-Navarro, C.J.
Supercritical fluid extraction and microencapsulation of bioactive compounds from red pepper (Capsicum annum L.) by-products

(2012) *Food Chemistry*, 133 (3), pp. 1045-1049. Cited 26 times.
doi: 10.1016/j.foodchem.2012.01.062

View at Publisher

36 Salihu, A., Alam, M.Z., Abdulkarim, M.I., Salleh, H.M.
Optimization of lipase production by Candida cylindracea in palm oil mill effluent based medium using statistical experimental design

(2011) *Journal of Molecular Catalysis B: Enzymatic*, 69 (1-2), pp. 66-73. Cited 53 times.
doi: 10.1016/j.molcatb.2010.12.012

View at Publisher

37 Santoyo, S., Lloría, R., Jaime, L., Ibañez, E., Señoráns, F.J., Reglero, G.
Supercritical fluid extraction of antioxidant and antimicrobial compounds from Laurus nobilis L. Chemical and functional characterization

(2006) *European Food Research and Technology*, 222 (5-6), pp. 565-571. Cited 34 times.
doi: 10.1007/s00217-005-0027-9

View at Publisher

38 Simopoulos, A.P.
The importance of the ratio of omega-6/omega-3 essential fatty acids

(2002) *Biomedicine and Pharmacotherapy*, 56 (8), pp. 365-379. Cited 1553 times.
doi: 10.1016/S0753-3322(02)00253-6

View at Publisher

39 Sugawara, T., Matsubara, K., Akagi, R., Mori, M., Hirata, T.
Antiangiogenic activity of brown algae fucoxanthin and its deacetylated product, fucoxanthinol

(2006) *Journal of Agricultural and Food Chemistry*, 54 (26), pp. 9805-9810. Cited 65 times.
doi: 10.1021/jf062204q

View at Publisher

40 Tanyildizi, M.S., Özer, D., Elibol, M.
Optimization of α-amylase production by Bacillus sp. using response surface methodology

(2005) *Process Biochemistry*, 40 (7), pp. 2291-2296. Cited 239 times.
doi: 10.1016/j.procbio.2004.06.018

View at Publisher

41 Turner, C., King, J.W., Mathiasson, L.
Supercritical fluid extraction and chromatography for fat-soluble vitamin analysis

(2001) *Journal of Chromatography A*, 936 (1-2), pp. 215-237. Cited 113 times.
doi: 10.1016/S0021-9673(01)01082-2

View at Publisher

42 Vasapollo, G., Longo, L., Rescio, L., Ciurlia, L.
Innovative supercritical CO2 extraction of lycopene from tomato in the presence of vegetable oil as co-solvent

(2004) *Journal of Supercritical Fluids*, 29 (1-2), pp. 87-96. Cited 106 times.
doi: 10.1016/S0896-8446(03)00039-1

View at Publisher

43 Wang, W.-J., Wang, G.-C., Zhang, M., Tseng, C.K.
Isolation of fucoxanthin from the rhizoid of Laminaria japonica Aresch

(2005) *Journal of Integrative Plant Biology*, 47 (8), pp. 1009-1015. Cited 29 times.
doi: 10.1111/j.1744-7909.2005.00054.x

View at Publisher

44 Wu, Y., Cui, S.W., Tang, J., Gu, X.
Optimization of extraction process of crude polysaccharides from boat-fruited sterculia seeds by response surface methodology

(2007) *Food Chemistry*, 105 (4), pp. 1599-1605. Cited 125 times.
doi: 10.1016/j.foodchem.2007.03.066

View at Publisher

45 Yan, X., Chuda, Y., Suzuki, M., Nagata, T.
Fucoxanthin as the major antioxidant in hijikia fusiformis, a common edible seaweed

(1999) *Bioscience, Biotechnology and Biochemistry*, 63 (3), pp. 605-607. Cited 264 times.
doi: 10.1271/bbb.63.605

View at Publisher

46 Zhang, P., Xiaohui, L.E.I., Zhongfang, L.E.I., Zhang, Z., Sugiura, N.
Study on Fucoxanthin Extraction from Laminaria Japonica with Ethanol Solution for Health Food Development
(2008) *Nogyo Shisetsu. Journal of the Society of Agricultural Structures*, 39 (1), pp. 9-16.

Jaswir, I.; Bioprocess and Molecular Engineering Research Unit (BPMERU), Department of Biotechnology Engineering, Faculty of Engineering, International Islamic University Malaysia (IIUM), Gombak, Kuala Lumpur, Malaysia; email:irwandi@iium.edu.my